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Pilot Network for Identification of Traveling Ionospheric Disturbances

Abstract:
Travelling Ionospheric Disturbances (TIDs) are the ionospheric signatures of atmospheric gravity waves. TIDs contribute to the energy and momentum exchange between different regions of the ionosphere, especially during geomagnetic storms. In addition, TIDs carry along information about their sources of excitations which may be either natural (energy input from the auroral region, earthquakes/tsunamis, hurricanes, solar terminator, and others) or artificial (ionospheric modification experiments, nuclear explosions, and other powerful blasts like industrial accidents). Their tracking is important because the TIDs affect all services that rely on predictable ionospheric radio wave propagation. Although a number of methods have been proposed to measure TID characteristics, none is able to operate in real time for monitoring purposes. In the framework of a new NATO multi-year project (2014 - 2017) we are exploiting for the first time the European network of high precision ionospheric DPS4D sounders and the related software to directly identify TIDs over Europe and specify in real-time the TID wave parameters from bottomside ionospheric measurements. The proposed TID diagnostics technique applies the Frequency & Angular Sounding (FAS) method that is based on measuring the variations of the angles-of-arrival and Doppler frequencies of ionospherically reflected HF radio signals. The FAS technique offers a possibility of using transmissions from broadcasting stations as probing signals leading to reduce overall system costs and expenditures by using a single receiving site to monitor several transmitters making measurements over a large area. On the operational side, the project will result in a pilot network of DPS4D ionospheric sounders in Europe, enhanced with a system to process in real-time the TID observations and issue warnings for TIDs and their potential disturbance in the TEC parameter over the area. Based on these warnings the end-users can put in action specific mitigation techniques to protect their systems. On the scientific side, the results of the FAS technique will provide us with high accuracy 3D electron density maps for the bottomside ionosphere to validate existing phenomenological models and to consider assimilation techniques for their improvement. First results from the FAS technique are expected at the end of 2015, while the project plans to deliver the warning system in 2017.